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Forest Insect and Disease Management

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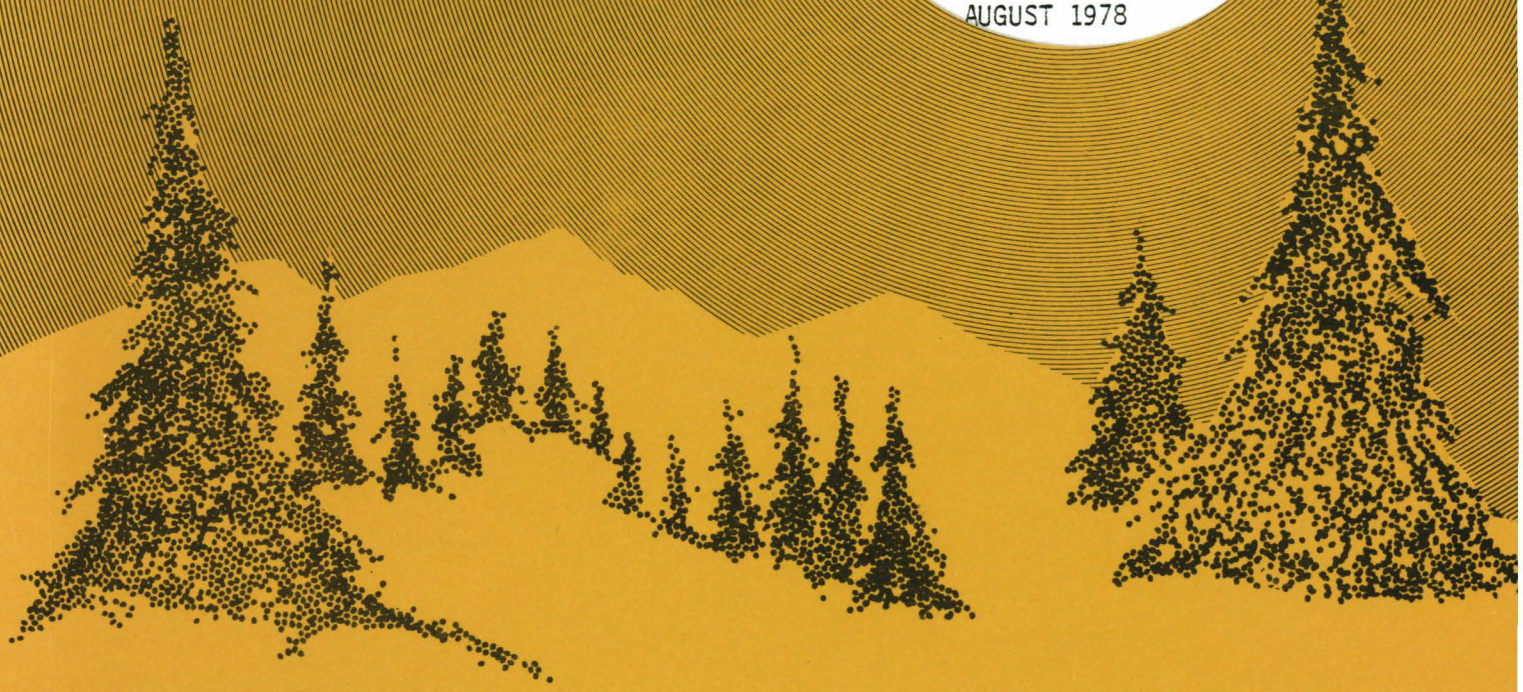
BIOLOGICAL
EVALUATION R2-78-8

THE WESTERN SPRUCE BUDWORM

San Juan, Pike and San Isabel,
and Arapaho and Roosevelt
National Forests

Colorado

AUGUST 1978



Rocky Mountain Region

U.S. Department of Agriculture Forest Service

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ABSTRACT

The western spruce budworm defoliated over 900,000 acres of Douglas-fir and white fir forest types in the Colorado Front Range in 1978. The San Juan National Forest supported only localized budworm infestations.

Egg mass surveys were conducted on the San Juan, Pike and San Isabel, and Arapaho and Roosevelt National Forests in August, 1978. Defoliation predictions for the San Juan National Forest in 1979 are light defoliation in the vicinity of Vallecito Reservoir, moderate in the vicinity of Beaver Meadows, and moderate in the Junction Creek area. Defolition on the San Isabel National Forest should be undetectable in 1979. Moderate defoliation is expected on the Pike National Forest in 1979. The Arapaho and Roosevelt National Forests should experience light defoliation during 1979.

INTRODUCTION

The western spruce budworm is the most serious defoliator in Douglas-fir and white fir timber types in the Rocky Mountain Region. Periodic epidemics have caused widespread and occasionally severe defoliation. Since 1974, Douglas-fir and white fir stands on the Pike and San Isabel National Forests and Douglas-fir stands on the Arapaho and Roosevelt National Forests have been sustaining injury from epidemic budworm populations.

Forest Insect and Disease Management monitors the western spruce budworm through annual aerial detection and egg mass surveys. Annual surveys are conducted to provide historical records of the progression and regression of the western spruce budworm within the Region and to provide concerned land managers with extent, intensity, and predictions of western spruce budworm activities.

Egg mass sample locations were determined at the discretion of FI&DM personnel with limited input from the Forest. The sampling schedule employed in 1978 was unable to cover all budworm infested areas within the Region because of constraints on time and manpower. However, should the need to sample additional areas be identified, the sample schedule could be adjusted to accomplish this objective.

The egg mass surveys described in this report were conducted on the San Juan, Pike and San Isabel, and Arapaho and Roosevelt National Forests in August 1978. The aerial survey for budworm detection was completed in July 1978.

In conjunction with monitoring budworm populations through aerial and ground surveys, FI&DM has undertaken a special project to assess the damage to Front Range forests caused by the western spruce budworm. Specifically, the project will estimate the amount of tree mortality, growth loss, and damage to understory regeneration caused by the budworm. When completed, this information should be of value to land managers.

BIOLOGY OF THE WESTERN SPRUCE BUDWORM

The western spruce budworm, *Choristoneura occidentalis*, Freeman, is a principal defoliator in spruce-fir forest types in the West. In Colorado, the budworm's preferred hosts are Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco, and white fir, *Abies concolor*

(Gord. and Glend.) Linbl.. Subalpine fir, *A. lasiocarpa* (Hook.) Nutt., Engelmann spruce, *Picea engelmannii* Parry, and blue spruce, *P. pungens* Engelm., are also attacked.

The western spruce budworm has one generation per year in Colorado. Adult moths emerge and mate in July. Females may lay a partial compliment of their eggs shortly after mating, the remainder are deposited after a migration period. Eggs are found in masses cemented to the undersides of host tree needles and hatch in approximately ten days. The newly hatched larvae do not feed, but seek hiding places under bark scales on branches, in twig crotches, or among lichens where they spin silken shelters (hibernacula) and overwinter.

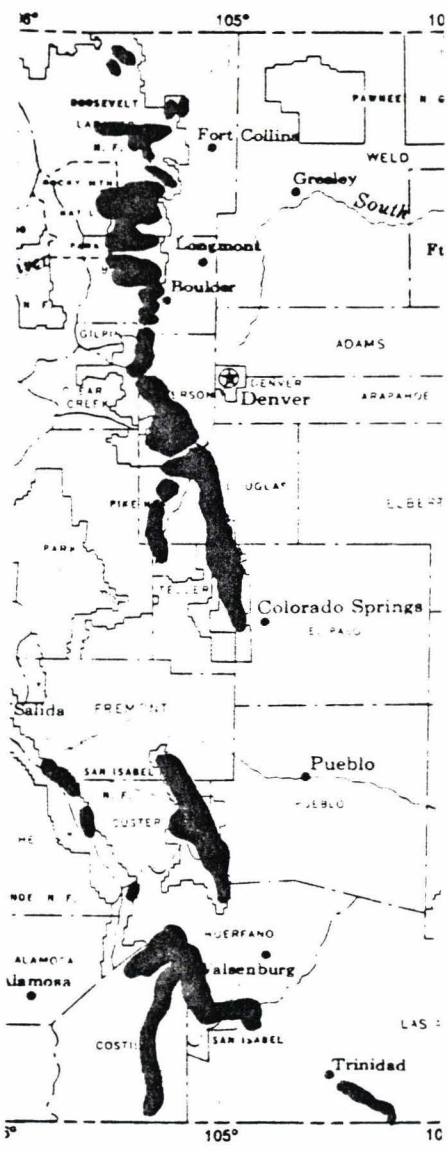
In the spring, larvae disperse to the foliage where they mine needles for one to two weeks. About the time buds begin to expand, larvae move into the buds and later, as the new shoots unfurl, spin loose feeding webs between shoots. Larvae prefer to feed on new foliage and become full grown in 30 to 40 days after feeding begins in the spring. Pupation takes place in feeding webs or on the foliage. Adult moths are not strong flyers, but may be carried considerable distances by air currents.

EXTENT OF THE OUTBREAK

Figure 1 illustrates the extent of the current epidemic within the Front Range (Pike and San Isabel, and Arapaho and Roosevelt National Forests) for the years 1976 through 1978. An aerial detection survey of the Front Range indicated over 967,000 acres (all ownership types) displaying budworm injury. Three centers of localized budworm activity occured on the San Juan National Forest (Figure 2).

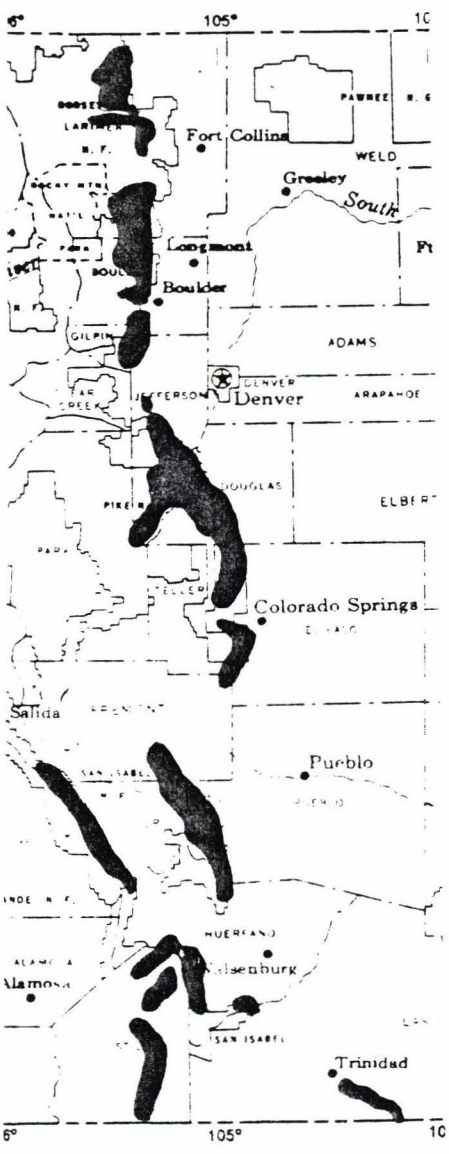
HOST STAND CONDITION

Mature stands of mixed Douglas-fir and white fir in the southern Front Range and Douglas-fir in the northern Front Range have suffered extensive and occasionally severe defoliation (up to 100% of new growth) in the years 1974 through 1978. The severity of tree damage caused by the western spruce budworm is directly related to the intensity and duration of defoliation. Stands displaying good vigor and growth can withstand occasional or



1976
Aerial Detection
Budworm
Survey

719,360 A



1977
Aerial Detection
Budworm
Survey

915,840 A

1978
Aerial Detection
Budworm
Survey

967,840 A

Figure 1. Budworm aerial detection survey for 1976-1978.

possibly one or two years of heavy budworm feeding without measurable injury. However, stands displaying poor vigor and growth (overmature and overstocked stands) will suffer varied amounts of tree injury depending on the intensity and duration of defoliation. Generally, budworm infestations caused varied amounts of tree deformity, seedling damage, seed destruction, and stand regeneration failure. Stands subjected to three and possibly four or more consecutive years of severe defoliation may incur top-killing, and an unknown amount of tree mortality principally in the smaller size class trees (< 5" d.b.h.). Radial growth of infested trees may be reduced through the duration of the infestation.

Damage to infested stands on the San Juan National Forest is less severe than Front Range forests. The outbreak in the vicinity of the Vallecito Reservoir appears to be the only chronic infestation. Tree injury, as previously described, is a possibility should the infestation continue.

EVALUATION METHODS

Egg mass surveys are the principal tool in evaluating budworm population trends and subsequent defoliation levels. Two similar survey procedures were used in this evaluation. A sequential sampling plan was used on the San Juan National Forest. While, a fixed plot sampling scheme was used on the Pike and San Isabel, and the Arapaho and Roosevelt National Forests.

San Juan National Forest. Egg mass densities and subsequent defoliation predictions were made using a sequential sampling plan developed by McKnight and associates (1970). Douglas-fir was the only tree species sampled. Sample trees were selected at random from suspected or known areas of budworm activity. Two 24-inch foliated branches were pruned from the midcrown of each sample tree (dominant or co-dominant trees). These foliage samples were bagged, numbered, and transported to a lab for examination. Foliage samples were examined for budworm egg masses. New and old egg masses were separated under a microscope. Numbers of new egg masses were summarized and the next year's defoliation predictions were made following McKnight's scheme (Table 1).

Table 1. Class Limits for Defoliation Predictions Based on Western Spruce Budworm Egg Mass Surveys [1/]

Class	New Egg Masses per 24 inch Branch	New Egg Masses per 1000 sq. inches Foliage	Defoliation Prediction [2/]
1	0.250 or less	1.0 or less	undetectable
2	0.275 to 1.0	1.1 to 4.0	undetectable in "static" infestations; light in "increasing" infestations
3	1.5 to 5.0	6.0 to 20.0	light in "static" infestations; moderate in "increasing" infestations
4	5.5 or more	22.0 or more	moderate or heavy

[1/] Adopted from McKnight et. al. 1970.

[2/] Percent defoliation of current growth

Undetectable = 0 to 5

Light = 5 to 35

Moderate = 35 to 65

Heavy = 65 and over

Pike and San Isabel, and Arapaho and Roosevelt National Forests. Sampling on these forests was accomplished using a fixed plot, cluster sampling scheme. This sample plan was developed by a west-wide Forest Service task force, and is currently being evaluated by Regional FI&DM Units. It differs from the sequential plan principally in that permanent plots are established and revisited annually during the evaluation period and sample trees are clustered. To implement this plan, budworm susceptible stands within these Forests were divided into entomological units according to geographical and managerial boundaries. These units contained several sample plots each consisting of three dominant or co-dominant Douglas-fir within close proximity. Two 27-inch foliated branches were pruned from the midcrown of each sample tree for a total of six branches per plot. Branch samples were handled in the same manner as those from the San Juan National Forest. Defoliation predictions are based on correlations of past egg mass densities and subsequent defoliation, and guidelines established by McKnight (1967) and McKnight et. al. (1970). Current year's defoliation estimate were made by examining 100 new shoots from each sample tree and compiling this information for all sample trees by entomological units. Defoliation categories were as follows:

Percent Defoliation of Current Growth

Category	Percent Defoliation
Undetectable	0 to 5
Light	5 to 35
Moderate	35 to 65
Heavy	65 and over

RESULTS

San Juan National Forest. Egg mass sampling was conducted at seven locations (Figure 2). Active infestations were found at three locations, the vicinity of Vallecito Reservoir (T. 36 N., R. 6 W.), Beaver Meadows (T. 35 N., R. 5 W.; T. 36 N., R. 5 W.), and Junction Creek (T. 36 N., R. 10 W.). Sampling results are presented in Table 2.

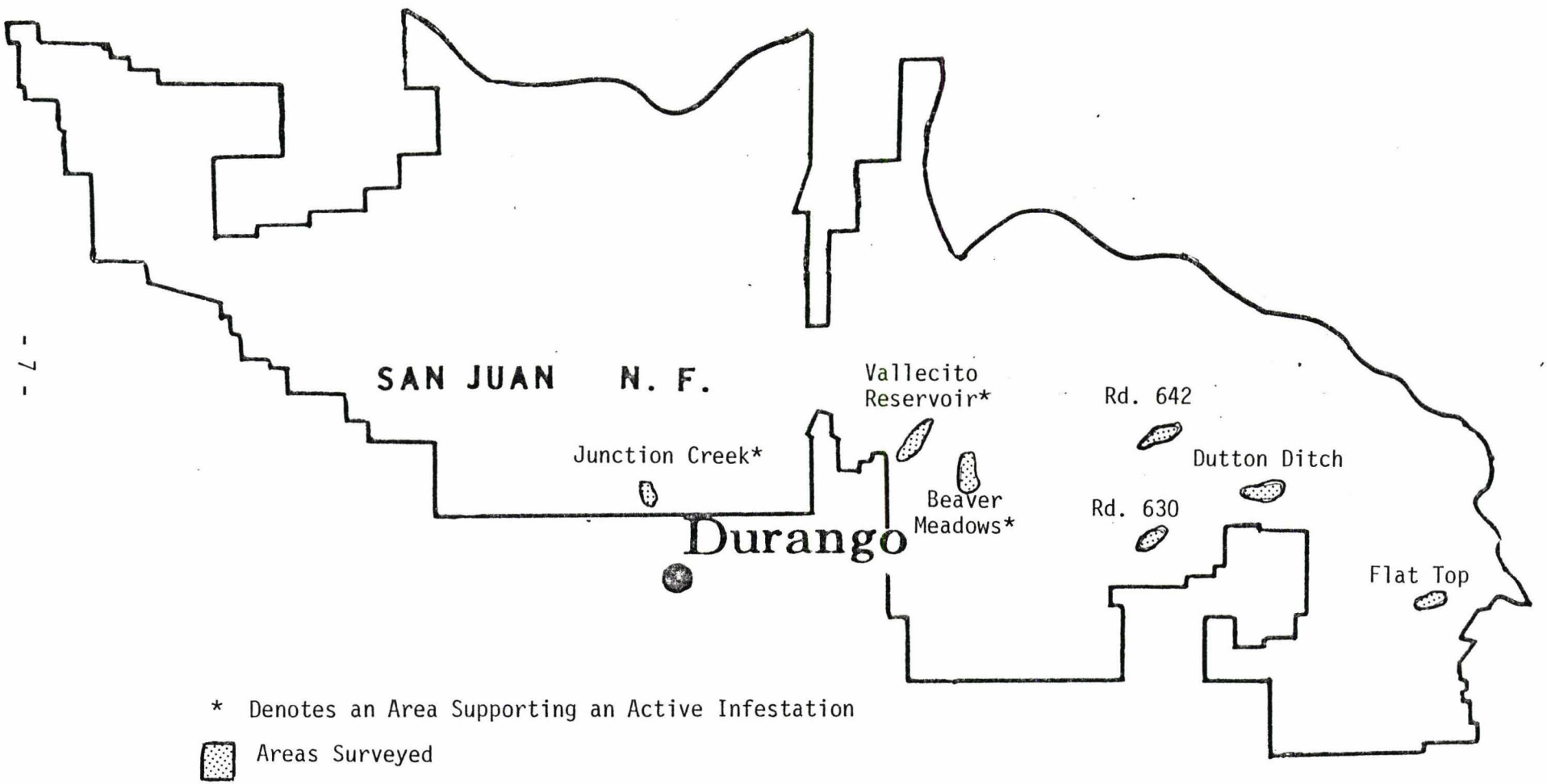


Figure 2. Areas Surveyed for WSB on the San Juan N.F.

Table 2. Results of Western Spruce Budworm Egg Mass Sampling on the San Juan National Forest in 1978.

Local [1]	Number of Branch Samples	New Egg Masses per 1000 sq. inches foliage	New Egg Masses per 24-inch Branch ($\bar{x}$)	78 Defoliation Estimate [2]	79 Defoliation Estimate [3]
Vallecito Reservoir	100	16.4	2.57	moderate	moderate
Beaver Meadows	60	9.5	1.9	light	moderate
Junction Creek	50	10.6	1.7	moderate	moderate
Road 630	12	0.5	0.08	undetectable	undetectable
Road 642	12	0	0	undetectable	undetectable
Dutton Ditch	12	0	0	undetectable	undetectable
Flat Top Mountain	20	0	0	undetectable	undetectable

[1] See Figure 2 for survey locations

[2] A visual estimate made from branch samples

[3] Table 1 explains prediction categories

The infestation in the vicinity of the Vallecito Reservoir has been ongoing since 1974. Defoliation in 1978 was moderate. Predicted defoliation in 1979 is moderate. The infestation in the Beaver Meadows area appears to be increasing with light defoliation observed in 1978. Predicted defoliation in 1979 is moderate. The Junction Creek area was ground surveyed for the first time in 1978 with moderate defoliation observed. Predicted defoliation in 1979 is moderate.

San Isabel National Forest. The forest was divided into three entomological units for budworm evaluation purposes; Wet Mountains, Sangre de Cristo Mountains, and the Spanish Peaks (Figure 3). Egg mass surveys were conducted within these units. Results of these surveys are presented in Table 3.

All areas sampled within the San Isabel National Forest indicated a decline in budworm activity. Defoliation in 1978 was light. Predicted defoliation in 1979 is undetectable.

Pike National Forest. Visible defoliation on this Forest has increased over 1977. The 1978 egg mass survey was conducted in the general area east of the South Platte River from the northern Forest boundary, south to Colorado Springs. Intensive sampling was conducted in the vicinity of Indian Creek campground and Little Scraggy Peak (Figure 4). Sampling results are presented in Table 4.

Budworm activity within the areas surveyed is increasing with moderate defoliation predicted for 1979. Tree damage in the areas surveyed was not severe. The western spruce budworm appears to be entering its third year of increased activity in these areas.

Roosevelt National Forest The western spruce budworm has caused extensive and occasionally severe defoliation, particularly in pure Douglas-fir stands, on this forest. Twenty-four locations were sampled in 1978. An additional three areas were intensively sampled, the Big Elk Meadows-Johnny Park area (T. 4 N., R. 72 W.), Magnolia (T. 1 S., R. 71 W.), and Federal lands surrounding Estes Valley [1/] (Figure 5). Survey results are presented in Table 5.

1/ Biological Evaluation R2-78-7 deals specifically with Estes Valley.

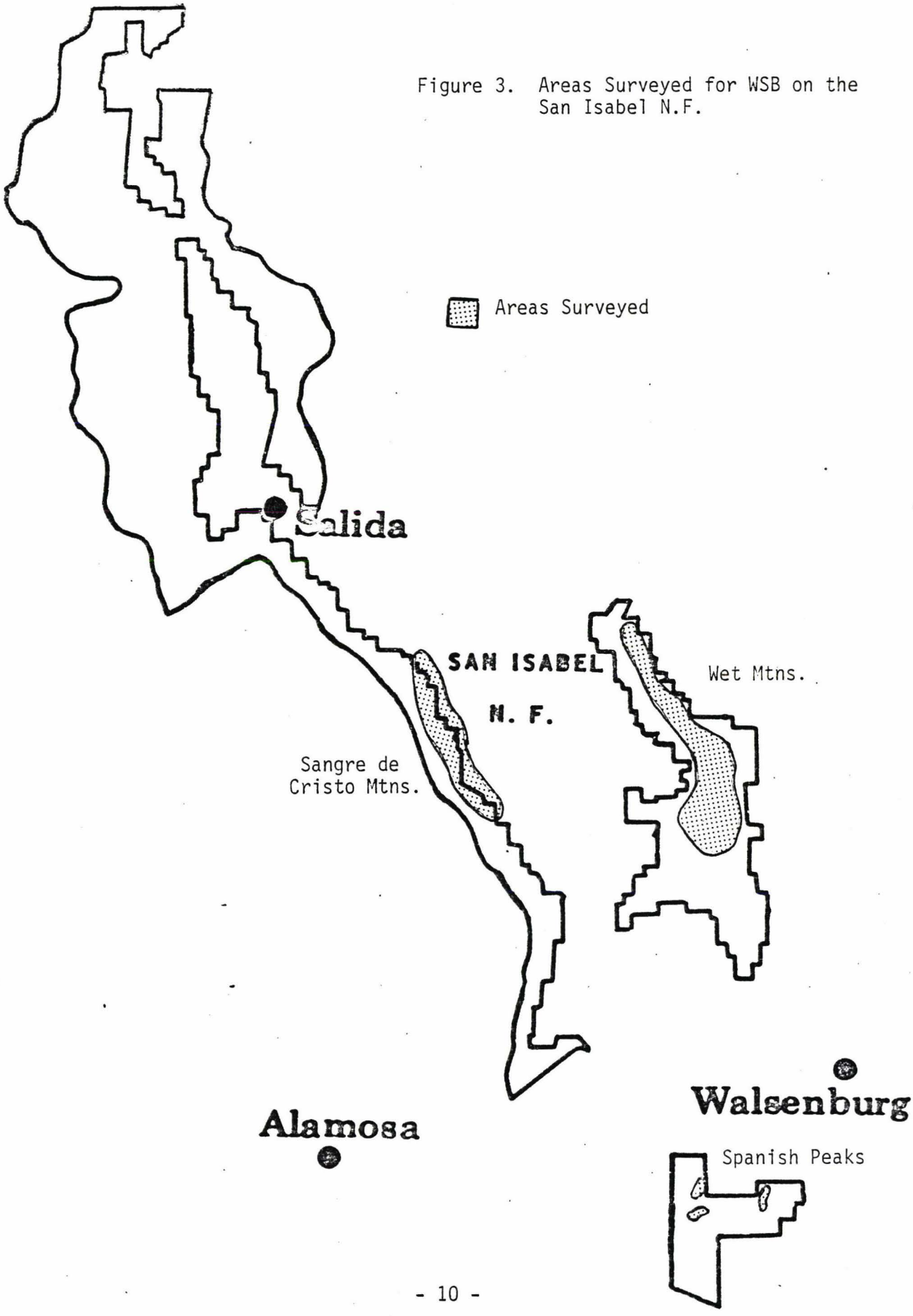


Figure 3. Areas Surveyed for WSB on the San Isabel N.F.

Table 3. Results of Western Spruce Budworm Egg Mass Sampling on the San Isabel National Forest

Local [1/]	Number of Branch Samples	New Egg Masses per 1000 sq. inches foliage	New Egg Masses per 24-inch Branch ($\bar{x}$)	78 Defoliation Estimate [2/]	79 Defoliation Estimate [2/]
Wet Mountains	144	2.1	0.5	light	undetectable
Sangre de Cristo Mountains	24	1.5	0.3	light	undetectable
Spanish Peaks	18	0.4	0.1	light	undetectable

[1/] See Figure 3 for survey locations

[2/] Table 1 explains defoliation classes

Figure 4. Areas Surveyed for WSB on the Pike N.F.

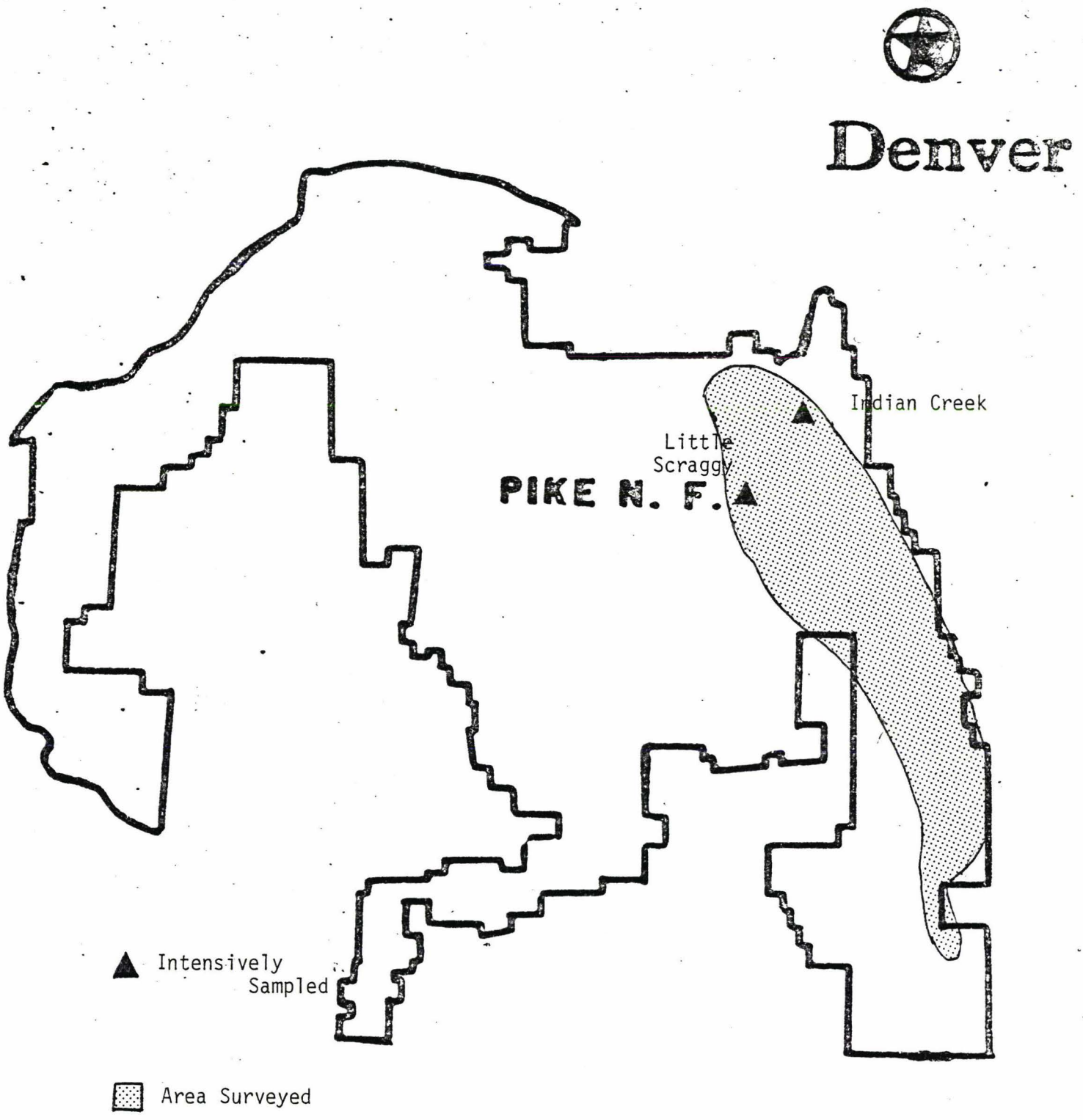


Table 4. Results of Western Spruce Budworm Egg Mass Sampling on the Pike National Forest

Local [1]	Number of Branch Samples	New Egg Masses per 1000 sq. inches Foliage	New Egg Masses per 24-inch Branch ($\bar{x}$)	78 Defoliation Estimate [2]	79 Defoliation Estimate [2]
Pike National Forest	102	19.0	4.5	moderate	moderate
Indian Creek	78	11.0	2.5	light	moderate
Little Scraggy Peak	30	15.5	3.4	moderate	moderate
Summary	210	15.2	3.5	moderate	moderate

[1] See Figure 4 for survey locations

[2] Table 1 explains defoliation classes

Figure 5. Areas Surveyed for WSB on the Roosevelt N.F.

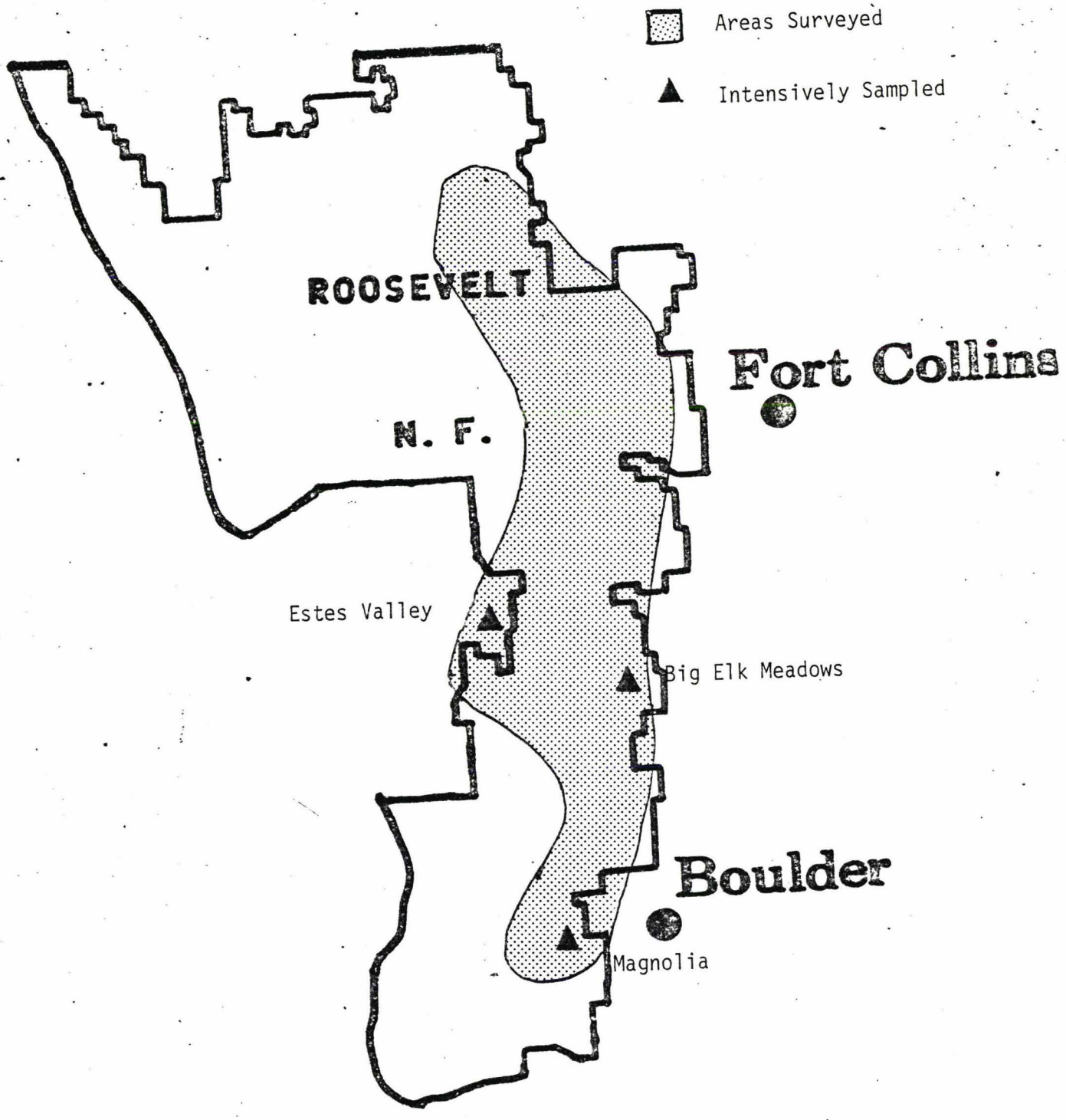


Table 5. Results of Western Spruce Budworm Egg Mass Sampling on the Roosevelt National Forest

Local [1]	Number of Branch Samples	New Egg Masses per 1000 sq. inches Foliage	New Egg Masses per 24-inch Branch ($\bar{x}$)	78 Defoliation Estimate [2]	79 Defoliation Estimate [2]
Roosevelt National Forest	144	11.4	2.5	moderate	"static" light
Big Elk Meadows	126	11.5	2.5	heavy	"static" light
Magnolia	60	3.8	0.9	light	"static" undetectable
Estes Valley	124	7.6	1.4	moderate	"static" light
Summary	454	8.6	1.8	moderate	"static" light

[1] See Figure 5 for survey locations

[2] Table 1 explains defoliation classes

The Roosevelt National Forest displays the severest budworm damage of any Front Range forest. Tree injury from locally chronic infestations is highly visible. Defoliation predictions for 1979 indicate light defoliation. However, 1977 and 1978 egg mass densities do not differ significantly. While the infestation may neither be increasing nor decreasing, this budworm population may be sufficient to severely defoliate chronically infested Douglas-fir stands. Stands not exhibiting chronic budworm infestation symptoms should experience only light defoliation in 1979.

RECOMMENDATIONS

Presently, resource managers have basically two alternatives in managing budworm infested lands. Where management objectives warrant, the first alternative is direct control. The second is no action. Silvicultural management of susceptible stands, often indicated as an important tool in reducing losses to forest insect pests, has not been adequately investigated in the central and southern Rocky Mountains for practical application.

The first alternative, direct control, involves aerial or ground applications of either a chemical or a microbial insecticide. Currently, aerial insecticidal applications cost approximately $6.75 per acre for a chemical pesticide (i.e. Sevin-4-Oil). Aerial applications of a microbial insecticide (i.e. *Bacillus thuringiensis* formulations) may be more expensive. Individual tree protection with ground applied insecticides may approach $6 per tree. Any insecticidal control project involving the western spruce budworm may require annual insecticidal application to achieve protection throughout the duration of the infestation. Considering the timber values of budworm susceptible stands within the Region, it is not likely direct treatment of the budworm can be justified based strictly on timber values. However, protection from budworm defoliation may be desirable and feasible within high value or high use areas, such as compgrounds, picnic grounds, other developed recreational areas, areas of scenic value, Christmas tree production areas, and other areas of high aesthetic value. These areas would need to be identified, the impact of defoliation determined, and an economic analyses applied. FI&DM can assist land managers with these analyses.

Currently, Sevin-4-Oil, Cythion ULV (malathion), Orthene, and some *Bacillus thuringiensis* formulations (Dipel ®, Thuricide ®, etc.) are registered with the EPA for aerial application against

the western spruce budworm. Sevin-4-Oil, *Bacillus thuringiensis*, and Kryocide are registered as ground applied insecticides.

The second alternative, a no action approach, may result in varied amounts of tree deformity, seedling damage, seed destruction, and poor regeneration in severely infested stands. Severe and consistent defoliation throughout the duration of the infestation may cause top-killing and some tree mortality. However, the greatest impact of budworm defoliation may be in high use and high value areas, where losses in aesthetic values may be a direct result of budworm infestations.

PESTICIDE USE STATEMENT

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key -- out of the reach of children and animals -- and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U. S. Department of Agriculture, consult your county agricultural agent or State Extension specialist to be sure the intended use is still registered.

LITERATURE CITED

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